

WHAT IS CLAIMED IS:

1. An electrostatic actuator comprising:

a movable element which is provided with
electrodes; and

5 a stator which is provided with driving electrodes
and inductive electrodes for generating electrostatic
induction in the electrodes of the movable element,
wherein

the electrodes of the movable element includes a
10 driven electrode part provided at a position opposite
to the driving electrodes of the stator, and an induced
electrode part provided at a position opposite to the
inductive electrodes of the stator; and

the movable element is displaced relatively to the
15 stator by generating electrostatic force between the
driving electrodes of the stator and the driven
electrode part in the movable element in which the
electrostatic induction is generated, by applying a
voltage to the driving electrodes of the stator, while
20 generating electrostatic induction in the electrodes of
the movable element through the induced electrode part
by applying a voltage to the inductive electrode of the
stator.

2. The electrostatic actuator according to
25 claim 1, wherein

the electrodes of the movable element includes
a first electrode and a second electrode which are

shaped substantially comb-like and interdigitated;

the induced electrode part corresponds to the base of the substantially comb-like electrode; and

the driven electrode part corresponds to the comb
5 tooth including the comb tooth end of the substantially comb-like electrode.

3. The electrostatic actuator according to claim 2, wherein

the movable element is placed on the front surface
10 of the stator; and

the movable element which has no electrical connection is displaced by applying a first AC voltage to the inductive electrodes of the stator and a second AC voltage to the driving electrodes of the stator.

15 4. The electrostatic actuator according to claim 3, wherein

the stator has the inductive electrodes and the driving electrodes connected and placed by four pieces with a predetermined cycle;

20 the movable element has the first electrode and the second electrode which are interdigitated;

the arrangement pitch of the first and second electrodes of the movable element is double the arrangement pitch of the driving electrodes of the
25 stator; and

a first traveling wave is generated in the electrode array of the movable element by generating

electric charges in the first and second electrodes of the movable element by applying the first AC voltage to the inductive electrode of the stator, and a second traveling wave is generated in the driving electrode array by applying the four-phase second AC voltage to the driving electrodes of the stator, and the movable element is displaced according to the change with time of the first and second traveling waves.

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10 5. The electrostatic actuator according to claim 4, wherein the ratio of an electrode width to an arrangement pitch length of the electrode array comprising the first and second electrodes of the movable element is 1:3 to 2:3.

15 6. The electrostatic actuator according to claim 3, wherein the speed of the movable element is controlled by the frequency difference between the first and second AC voltages.

20 7. The electrostatic actuator according to claim 6, wherein the movable element is stopped by setting the frequency difference between the first and second AC voltages to zero.

8. The electrostatic actuator according to claim 3, wherein

25 the stator has at least an array of driving electrodes arranged with a predetermined pitch on the surface of insulating base material, and a first to fourth common lines to connect the driving electrodes

by four pieces;

the electrostatic actuator further comprising:

5 a first transformer which generates AC potentials of 0-degree phase and 180-degree phase in the arrangement space of the driving electrodes of the stator; and

10 a second transformer which generates AC potentials of 90-degree phase and 270-degree phase in the arrangement space of the driving electrodes of the stator; and

the phase of the voltage applied to the primary side of the first transformer is different by 90 degrees from the phase of the voltage applied to the primary side of the second transformer.

15 9. The electrostatic actuator according to claim 3, wherein

the voltage applied to the driving electrode of the stator is a multi-phase AC voltage with three or more phases; and

20 one cycle pitch composed of the first electrode and second electrode of the movable element is equal to one cycle pitch of the driving electrodes of the stator.

25 10. The electrostatic actuator according to claim 2, further comprising:

a first connection member which connects a plurality of movable elements; and

a second connection member which connects
a plurality of stators, and that

the plurality of movable elements and stators are
stacked through the first and second connection
5 members, and the plurality of movable elements and
first connection member are moved.

11. The electrostatic actuator according to
claim 2, wherein

the movable element is a rotating rotor in which
10 a first electrode with radially spreading comb-like end
electrodes, and a second electrode with centripetally
arranged comb-like end electrodes are interdigitated;
and

the stator is composed of two or more inductive
15 electrodes placed on the circumference of a disk, and
driving electrodes connected and arranged by multiple
numbers with a predetermined cycle angle.

12. The electrostatic actuator according to
claim 11, wherein the rotor and stator are stacked to
20 be multiple layers centering around a common rotation
shaft, and the rotation torque generated by a plurality
of rotors is taken through the common rotation shaft.

13. The electrostatic actuator according to
claim 2, wherein

25 the movable element is composed of a first
electrode having a comb-tooth shape and a second
electrode having the substantially same shape which are

interdigitated, and placed on the surface of a cylinder so that the directions of the first and second electrodes are aligned as a straight line, the movable element moving parallel on a cylinder shaft; and

5 the stator is composed of driving electrodes arranged to be aligned with two or more inductive electrodes placed on the straight lines on a cylinder.

14. The electrostatic actuator according to claim 2, wherein the movable element is
10 a circumferentially rotating movable element composed of a first electrode having a comb-tooth shape and a second electrode having the substantially same shape which are interdigitated and placed on the surface of a cylinder so that the directions of the first and
15 second electrodes are aligned as a circle; and

 the stator is composed of two or more inductive electrodes placed on the circumference of a cylinder and driving electrodes arranged to be aligned with the inductive electrodes as a circumference.

20 15. An electrostatic actuator comprising:

 a stator having two or more inductive electrodes arranged one of substantially parallel and concentric and a plurality of driving electrodes arranged with a predetermined cycle;

25 a movable element having at least two combined electrode structures; and

 a displacement means for displacing the movable

element by generating electric charges in the
electrodes of the movable element via the inductive
electrodes of the stator, and generating electrostatic
force between the electric charges and the driving
5 electrodes of the stator.

16. The electrostatic actuator according to
claim 15, wherein the electrode of the movable element
is composed of a first electrode having a comb-tooth
shape and a second electrode having the substantially
10 same shape which are interdigitated.

17. The electrostatic actuator according to
claim 15, wherein

the movable element is placed on the front surface
of the stator; and

15 the displacement means displaces the movable
element which has no electrical connection, by applying
a first AC voltage to the inductive electrode of the
stator and a second AC voltage to the driving
electrodes of the stator.

20 18. The electrostatic actuator according to
claim 17, wherein

the stator has the inductive electrodes and the
driving electrodes connected and placed by four pieces
with a predetermined cycle;

25 the movable element has a first electrode and
second electrode which are interdigitated;

an arrangement pitch of the first and a second

electrodes of the movable element is double an arrangement pitch of the driving electrodes of the stator; and

5 the displacement means generates a first traveling wave in the electrode array of the movable element by generating electric charges in the first and second electrodes of the movable element by applying the first AC voltage to the inductive electrodes of the stator, generates a second traveling wave in the array of the driving electrodes by applying the four-phase second AC
10 voltage to the driving electrodes of the stator, and displaces the movable element according to the change with time of the first and second traveling waves.

19. A method of displacement comprising:

15 placing inductive electrodes and driving electrodes at different positions where electrodes of a movable element and a part of them face each other; and

generating electric charges in the electrodes of
20 the movable element by electrostatic induction by applying a voltage to the inductive electrodes, and displacing the relative position of the electrodes of the movable element to the driving electrodes by the electrostatic force by the electric charges generated
25 in the driving electrodes and the electrodes of the movable element.